Psychology, Evaluation, and Technology in Educational Research
6 (2), 2024, 203-212

Available Online: http://petier.org/index.php/PETIER

PETiER
Psychology, Evaluation, and Technology in Educational Research

The effect of chem-preneurship-based project learning on students' creativity

Mohammad Agus Prayitno [a]*, Mar'attus Solikhah [b], Nur Khamidah [c]

Universitas Islam Negeri Walisongo. Jl. Walisongo No 3-5 Semarang 50185, Indonesia

[c] mohammadagus@walisongo.ac.id; [b] maratussolihah96@gmail.com; [b] nur.khamidah@gmail.com

* Corresponding Author.

Received: 30 December 2022; Revised: 28 November 2023; Accepted: 8 April 2024

Abstract: 21st-century education not only involves aspects of knowledge but also emphasizes aspects of skills, such as critical thinking skills, creative thinking skills, communication, and collaboration. Creative thinking skills can be developed through contextual learning activities. One type of contextual learning is Chem-preneurship-based Project Learning (CBPL). CBPL trains students to be able to creatively design ideas, make products, design packaging, and do marketing. This study aimed to determine the effectiveness of the CBPL model. The research method used is descriptive quantitative. The population in this study were students of the 3rd semester of the department of chemistry. The sample of this study was 37 students who took Chem-partnership courses. The data analysis used is non-parametric statistical analysis. The results of the Wilcoxon test on student creativity obtained sig < 0.05, which means there were differences in student creativity before and after CBPL learning was implemented. The average score of students' creativity has increased from 58.83 to 82.34.

Keywords: CEP, Chem-preneurship, Creativity, PjBL.

How to Cite: Prayitno, M. A., & Khamidah, N. (2024). The effect of chem-preneurship-based project learning on students creativity. *Psychology, Evaluation, and Technology in Educational Research*, *6*(2), 203-212. https://doi.org/10.33292/petier.v6i2.158

INTRODUCTION

Education plays a very important role in life. According to the National Education System Law, education's role is to form active students who develop spiritual power, self-control, character, intelligence, noble character, competence, community, nationality, and national potential. Rahayu and Tisnawati (2014) believe that the education level plays an important role in determining employment. The higher a person's education, the more likely that person is to get a suitable job. Open unemployment in Indonesia is very high. Based on data from the Central Statistics Agency, information was obtained that open unemployment in Indonesia in August 2023 was 5.32% of the total workforce in August 2023, namely 147.71 million people. In August 2023, the working population will still be dominated by elementary school graduates or below (no/never been to school/not finished elementary school/finished elementary school), namely 36.82 percent. Meanwhile, the working population who graduated from Diploma I/II/III and Diploma IV, Bachelor's, Master's, and Doctoral degrees is in last place, namely 12.76 percent. The detailed Open Unemployment Rate in Indonesia in August 2023 can be seen in Figure 1.

Based on age group, the Open Unemployment Rate in August 2023 is dominated by the 15-24-year age group, reaching 19.4 percent. Meanwhile, the TPT for the elderly (60 years and over) is the lowest, 1.28 percent (Badan Pusat Statistik, 2023). In more detail, the Open Unemployment Rate by age group can be seen in Figure 2.

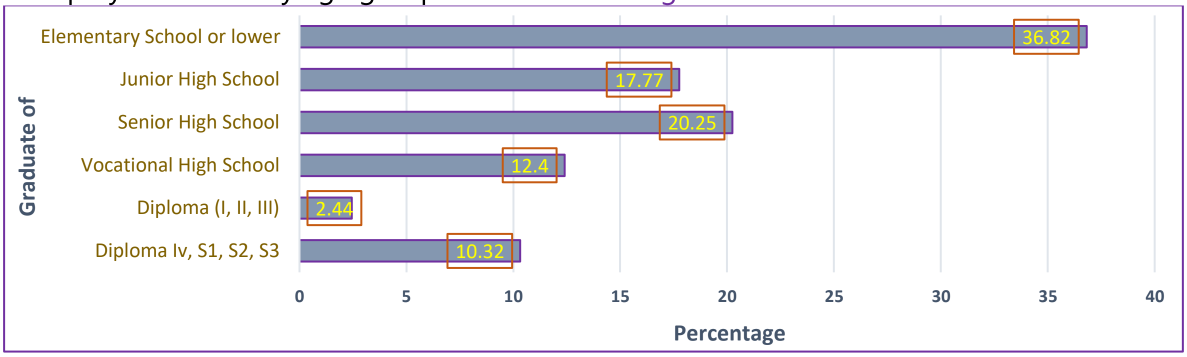

Figure 1. Percentage of Working Population by Education Completed

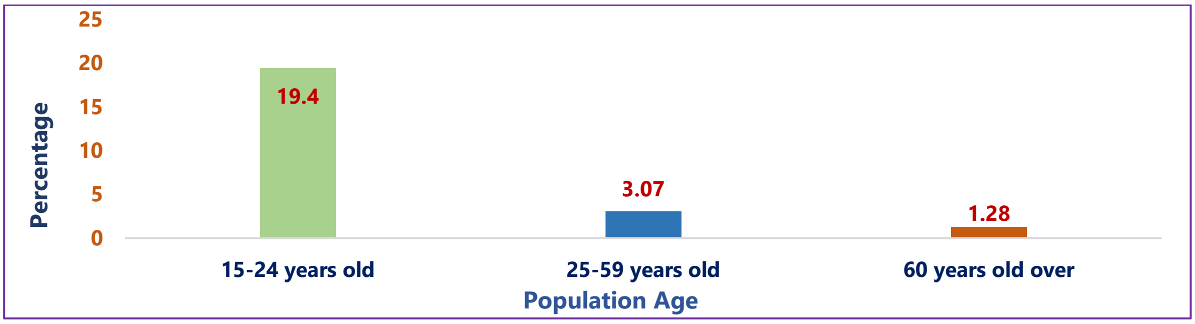

Figure 2. Percentage of TPT by Age Group

Figure 2 implicitly shows that high school and university graduates dominate the Open Unemployment Rate. Based on the description above, it is not wrong if the government calls for schools or madrasas to provide 21st-century skills to students. 21st-century skills are higher-order thinking skills, deeper learning outcomes, and communication abilities. The goal of education in the 21st century is to produce human resources that have strong communication and collaboration skills, are proficient in operating technology, are able to think creatively, and are critical in solving a problem (Larson & Miller, 2011). Binkley et al. (2012) group 21st-century education into four things, namely ways of thinking, consisting of creativity and innovation, critical thinking, problem-solving skills, accuracy in decision making, learning in learning; a way of working, including communication and cooperation; tools for work, including general knowledge and skills in using ICT; a way to live that consists of a career and responsibilities.

21st-century education not only involves knowledge but also emphasizes skills such as creativity, communication, and collaboration (Prayogi & Estetika, 2020). Partnership, 21st Century Skills, divides 21st-century skills, namely critical thinking, students are expected to be able to respond critically to knowledge and knowledge and use it for the benefit of humanity; problem-solving, students can overcome the problems they face in social life; communication, students can identify and utilize communication tools and techniques to receive and convey information;) Collaboration: students can cooperate well with anyone to develop their networks.

Entrepreneurship is one of the courses in the UIN Walisongo Chemistry study program, which can equip students with 21st-century skills. The entrepreneurship course aims for students to have entrepreneurial abilities and skills in the field of chemistry as required by the 21st-century learning objectives. The aim of this excellent course must be supported by good learning stages as well. Based on the results of observations, information was obtained that (a) the chem-preneurship lecture process had been implemented well, namely by combining several learning models/methods; (b) The learning model used in entrepreneurship courses is

Chem-preneurship Based Project Learning (CBPL), where students work in groups in planning, making, and marketing chemical-based entrepreneurial products, (c) Measurement of learning outcomes is only seen based on cognitive value, and the value of the product being used. Developed, and (d) students' creative thinking skills measurements have never been carried out.

On the other hand, many natural resources have not been utilized optimally, such as banana tree trunk waste. Ripe bananas are usually only taken from the fruit, while the stems are cut down and thrown into the river, which causes blockage in the river flow. If left lying around in the fields/rice fields, it can cause an unpleasant odor in the surrounding area. Therefore, banana stems/tubes can be used in making snacks, such as chips, or as an additional ingredient in other products. Utilizing waste in entrepreneurial products can indirectly improve students' creativity in processing waste into useful products.

Making chemical entrepreneurial products from natural materials using the CBPL learning model can be called a Chem-preneurship Based Project Learning. The syntax of this learning model is the same as the syntax of the Project-based Learning model. Only the projects produced are more specific to chemistry-based entrepreneurial projects and are carried out in groups. Chem-preneurship Based Project Learning is contextual chemistry learning that allows students to easily understand the material presented. Students also gain experience in processing a natural material into a product that has a sales value in society (Jamilah & Kamaludin, 2019). In addition, CBPL can improve the quality of learning on certain materials and make students proficient at creating a product and buying and selling it (Ishak et al., 2021).

The process of making products in CBPL encourages students to be creative and look for ideas for making products that have economic value from natural materials or unused waste. Project-based Chem-preneurship Learning also trains students to communicate, create products, and market (Prayitno et al., 2020). Furthermore, CBPL can enhance students' entrepreneurial potential as well as provide innovative solutions for sustainable development (García-González & Ramírez-Montoya, 2021). Based on this, CBPL is the right learning to equip students to compete in the 21st century. This research aims to determine the effectiveness of the Project-based Chem-preneurship Learning approach on students' creative thinking skills.

METHODS

This research aims to determine the effectiveness of the CBPL model on students' creativity. The population in this study was 68 students of the 3rd-semester Chemistry study program. The sample in this study was 24 Chemistry 3A students. This research uses observation techniques with an instrument for collecting observation sheets. This type of research is quasi-experimental with a one-group pretest-posttest design. The observation sheet instrument is prepared with reference to indicators of creative thinking skills, which include fluency, flexibility, originality, and elaboration. The data analysis used was the Wilcoxon non-parametric statistical test, which compared students' creative thinking skills scores before and after learning using the Project-based Chem-preneurship learning model. The category of enhanced creative thinking skills is calculated using the N-gain score.

RESULTS AND DISCUSSION

Creativity is a person's creative thinking, expertise, and skills based on their experience and qualifications (Shafi et al., 2020). A creative person can share new and useful ideas to make the changes needed to produce something. Greenstein (2012) defines creativity as creating something new through imaginative skills. Creativity indicators consist of Curiosity, Fluency, Originality, Elaboration, Imagination, and Flexibility (Greenstein, 2012). The scope of these six indicators is presented in detail in Table 1.

Table 1. Indicator of Creativity

Indicator	Scope
Curiosity	probing, asking questions, and looking for more understanding
Fluency	generation of several concepts
Originality	concepts that are original, new, distinct, or unusual
Elaboration	concepts that exhibit intricate detail or enhance already-existing detail
Imagination	create, come up with, or invent novel concepts or goods
Flexibility	concepts that illustrate a range of options

Guilford (1966) describes the four characteristics of creativity. These four characteristics are described in Table 2.

Table 2. Guilford's four creativity characteristics. Characteristics

Characteristic	Description
Fluency	People may come up with a lot of ideas and respond quickly when faced with challenges. The quantity of replies, the quality of the correlation between answers, and the time taken to conceive the concept or provide the answer are all indicators of fluency.
Originality	Being original involves having the ability to come up with unique or uncommon concepts while also considering their viability.
Flexibility	When faced with challenges, individuals possess the adaptability to shift their perspective and tackle the issue through multiple methods.
Elaboration	Elaboration is the ability to think carefully or to improve and polish the details.

In this study, student creativity was measured using four of the six creativity indicators (Greenstein, 2012): fluency, flexibility, originality, and elaboration. The detailed description of these indicators is presented in Table 3.

Table 3. Indicators and Sub-Indicators of Creativity

Indicators of Creativity	Sub Indicator
Fluency	a. spark lots of ideas, lots of answers, lots of problem-solving, lots of questions smoothly.
	b. Provides many ways or suggestions for doing various things;
Flexibility	a. generates varied ideas, answers, or questions.
	b. See a problem from different points of view.
	c. Look for many alternatives or different directions.
	d. Able to change the way of approaching or thinking.
Originality	a. able to enrich and develop an idea or product.
	b. Adding or detailing the details of an object, idea, or situation so that it becomes more interesting.
Elaboration	a. able to give birth to new and unique expressions.
	b. Think of unconventional ways.
	c. Able to create unusual combinations from its parts.

The sub-indicators (Table 3) are then explained in detail in the form of validated statements and then used to obtain pre-test and post-test data on student creativity. Student creativity score data before and after learning is presented in Figure 3.

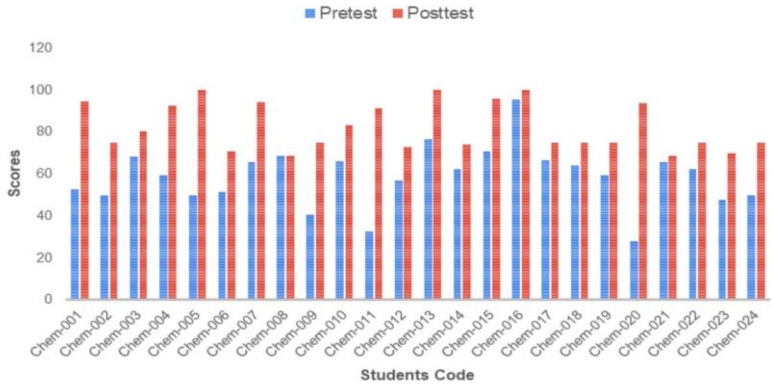

Figure 3. Student's creative thinking skills score before and after treatment

This research was analyzed using non-parametric analysis techniques. The non-parametric analysis used in this study was the Wilcoxon test. The Wilcoxon test results obtained a sig score <0.05. This means there are differences in students' creative thinking skills before and after the Project-based Chem-preneurship project learning activities. The results of the Wilcoxon test data on students' creative thinking skills are presented in detail in Table 4.

Table 4. Wilcoxon Creativity Test Results

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	6629.350	1	6629.350	40.285	0.000
Within Groups	7569.810	46	164.561		
Total	14199.160	47			

The N-gain score obtained was 0.56. This means that the increase in students' creativity after implementing CBPL is in the medium category. The detailed increase in students' creativity scores is presented in Table 5.

Table 5. Increasing Student Creativity

	Creativity Score			N-gain	Category
	Lowest	Highest	Average		
Pretest	28.10	95.30	58.83	0.56	Medium
Posttest	68.80	100.00	82.34		

The average pre-test and post-test scores of students' creativity in CBPL are presented in Figure 4.

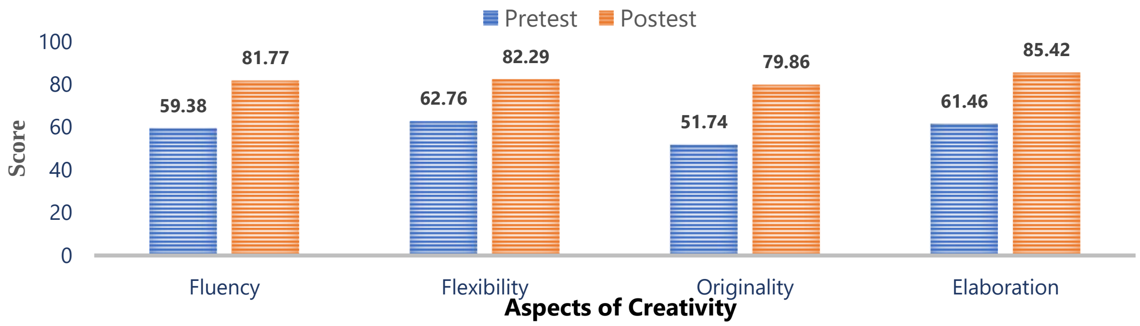

Figure 4. Average Pre-test and Post-test Scores for Creativity

CBPL is a learning project based on chemical entrepreneurship. CBPL emphasizes that students identify problems in the environment and find solutions to overcome these problems by making chemical entrepreneurial products. Some examples of products made by students in CBPL learning are shoe-washing soap from lerak fruit waste and shrimp shells, soap made from blood cockle shell waste and seaweed, and renjana perfume from orange peel waste and jasmine flower extract. These business opportunity ideas are obtained by students from the results of observations they have made previously so that students can creatively identify entrepreneurial opportunities based on existing problems.

The CBPL stages carried out in this research modify the project-based learning stages. The CBPL stages consist of problem presentation, observation, planning, scheduling, assessment, and evaluation. The stages of learning activities carried out are described in Table 6.

Table 6. CBPL Syntax and Learning Activities

CBPL Stages	Learning Activities
1. Presentation of the Problem	- lecturers ask basic questions related to problems in life, such as problems regarding waste and fossil fuels, and other questions related to real conditions in life. - Students provide solutions/answers to solve contextually asked problems.
2. Observation	- students make observations regarding chemical entrepreneurial opportunities related to the problems that have been raised. Observations were carried out in groups.
3. Planning	- based on the solutions and observation results, students are invited to discuss in groups to develop a plan for creating a chemical entrepreneurship project. - students determine the type of chemical entrepreneurship project.
4. Scheduling	- students design a schedule for completing the chemical entrepreneurship project by paying attention to the predetermined time limit. - schedule is consulted with the lecturer.
5. Creation of chemical entrepreneurship projects and monitoring	- students' work on chemical entrepreneurship projects, starting from the production process to the product packaging process. - lecturers monitor the progress of student projects and provide input/direction regarding products made by students.
6. Assessment	- students discuss the feasibility of the project they have created in front of the class. - students make offers or market the chemical entrepreneurship products that have been created. - students collect work reports on chemical entrepreneurship projects. - lecturers assess the activities carried out by students. In this research, the assessment focused on students' creativity in assembling ideas into products with economic value and students' creativity in packaging products.
7. Evaluation	- lecturers provide opportunities for students to reflect and evaluate the learning process that has been carried out.

Research data analysis, as shown in Table 4, shows that the significance value is <0.05. This means that student creativity has increased after learning the CBPL model. The results of this study are in accordance with the research results of (Biazus & Mahtari, 2022; Misrochah, 2021; Rizkasari et al., 2022; Ruwanda & Andriana, 2023; Setiawan et al., 2021), concludes that project-based learning can increase student creativity. Project-based learning helps students discover new concepts and experiences and increases their creativity in solving problems in groups through collaboration, making it meaningful learning (Rizkasari et al., 2022). CBPL learning invites students to think fluently, flexibly, originally, and elaborately to solve the problems they face. In CBPL learning, students are encouraged to find solutions to problems through creating chemical entrepreneurship projects. Not only that, students are also encouraged to package the products resulting from their project work and then market them or sell them to the public.

The CBPL model can improve students' skills and creativity in creating work (Prajoko et al., 2023; Sari & Angreni, 2018). Project-based learning provides opportunities for students to acquire skills using the principle of learning by doing (Sari & Angreni, 2018). This is in line with Saefudin (2012), who states that project-based learning allows students to research, plan, design, and reflect on project creation. R. Mursid et al. (2022) believe that project-based learning can improve learning outcomes and help students improve their quality of life, increase knowledge, solve social problems, develop talents and interests, and familiarize them with adapting to scientific developments. Project-based learning allows students to solve various problems they face (Lince, 2016), so it can potentially train and increase students' creativity in their work (Sari & Angreni, 2018).

CBPL is student-centered learning. Students are given the freedom to develop their creativity in solving problems through entrepreneurial projects individually or in groups so that learning becomes more enjoyable (Prayitno et al., 2024; Rizkasari et al., 2022). The CBPL model involves students working on complex problem-based tasks based on learning material and connecting them to the surrounding context. Students are given the opportunity to make observations, surveys, or analyze problems in groups (Yanti & Novaliyosi, 2023). In the CBPL learning process, students are encouraged to actively ask, investigate, explain, and interact with the problems given. The results of the investigations carried out by students will be produced in the form of products, which will then be presented (Oktaya & Panggabean, 2022).

Aspects of student creativity have increased quite significantly. The highest increase in the creativity aspect was in the elaboration aspect, with an N-gain score of 0.62, followed respectively by the aspects of originality (0.58), fluency (0.55), and flexibility (0.52). The increase in each aspect of creativity shows that the CBPL model is a learning model that invites students to think divergently. The CBPL model not only focuses on the final result but also emphasizes how students creatively solve a problem by creating chemistry-based entrepreneurial projects. The CBPL model is an innovative, student-centered learning model that places the teacher as a motivator and facilitator (Prayitno et al., 2024). Students are given the opportunity to work autonomously to construct their learning. In CBPL learning, students identify and look for solutions to solve problems. Solving these problems motivates students to be more creative, thus making learning more meaningful (Surya et al., 2018).

The results of the creativity N-gain analysis obtained a score of 0.56 in the medium category. This means that student creativity can still be improved through developing or integrating project-based learning models with other learning models. Zulyusri et al. (2023) suggest that the project-based learning model has a higher level of critical and creative thinking. This is because project-based learning syntax can stimulate students to actively participate in learning activities to maximize knowledge and critical and creative thinking skills. Purwanti et al. (2022) suggest that project-based learning has several advantages, including (a) increasing student motivation and skills to complete important tasks, (b) increasing student activity in solving complex problems, (c) applying ergonomic, hygienic, precise, fast principles, and metacognitive in handling creative media and materials, as well as (d) producing works that are ready to use and can be used in life. Based on the description stated above, choosing the right learning model is very important. The learning model determines learning outcomes and the level of student creativity in applying the concepts that have been presented.

CONCLUSION

Based on the description that has been presented in the research results and discussion, it can be concluded that the CBPL model is effective in developing student creativity. The average score for each student's creativity increased after CBPL learning activities were carried out. All aspects of creativity have increased after learning CBPL. The aspect of creativity that experienced the highest increase was the elaboration aspect. This means that students can create unique and new products through different methods in general and create unusual combinations in product development. The results of the N-gain analysis in the fluency aspect were 0.55, flexibility was 0.52, originality was 0.58, and elaboration was 0.62 with a moderate increase category. The results of the Wilcoxon test on student creativity obtained sig < 0.05, meaning there are differences in student creativity before and after implementing CBPL learning. Based on this, the CBPL model can be implemented in lecture activities to make it possible to apply the model.

REFERENCES

Badan Pusat Statistik. (2023). *Keadaan Ketenagakerjaan Indonesia Agustus 2023*. Badan Pusat Statistik.

Biazus, M. de O., & Mahtari, S. (2022). The impact of project-based learning (PjBL) model on secondary students' creative thinking skills. *International Journal of Essential Competencies in Education*, *1*(1), 38–48. https://doi.org/10.36312/ijece.v1i1.752

Binkley, M., Erstad, O., Herman, J., Raizen, S., Ripley, M., Miller-Ricci, M., & Rumble, M. (2012). Assessment and Teaching of 21st Century Skills. In P. Griffin, B. McGaw, & E. Care (Eds.), *Assessment and teaching of 21st century skills* (Vol. 9789400723). Springer Netherlands. https://doi.org/10.1007/978-94-007-2324-5

García-González, A., & Ramírez-Montoya, M. S. (2021). Social entrepreneurship education: changemaker training at the university. *Higher Education, Skills and Work-Based Learning*, *11*(5), 1236–1251. https://doi.org/10.1108/HESWBL-01-2021-0009

Greenstein, L. (2012). *Assessing 21st century skills: A guide to evaluating mastery and authentic learning*. Corwin a SAGE Company.

Guilford, J. P. (1966). Measurement and creativity. *Theory Into Practice*, *5*(4), 185–189. https://doi.org/10.1080/00405846609542023

Ishak, P. M., Harizon, H., & Muhaimin, M. (2021). Penggunaan model pembelajaran project based learning terintegrasi chemo-entrepreneurship dan hubungannya dengan life skill siswa dalam pembelajaran kimia. *Jurnal Inovasi Pendidikan Kimia*, *15*(1), 2745–2753. https://doi.org/10.15294/jipk.v15i1.26142

Jamilah, S., & Kamaludin, A. (2019). Pengembangan buku panduan pendidik berorientasi chemo-entrepreneurship (CEP) pada materi ikatan kimia SMA\MA kelas X. *JURNAL PENDIDIKAN SAINS (JPS)*, *7*(1), 36. https://doi.org/10.26714/jps.7.1.2019.36-46

Larson, L. C., & Miller, T. N. (2011). 21st century skills: Prepare students for the future. *Kappa Delta Pi Record*, *47*(3), 121–123. https://doi.org/10.1080/00228958.2011.10516575

Lince, R. (2016). Creative thinking ability to increase student mathematical of junior high school by applying models numbered heads together. *Journal of Education and Practice*, *7*(6), 206–212.

Misrochah, N. (2021). Model pengembangan pembelajaran PJBL berbasis proyek untuk meningkatkan kreatifitas siswa. *Indonesian Journal of Learning Education and Counseling*, *3*(2), 140–147. https://doi.org/10.31960/ijolec.v3i2.741

Prajoko, S., Sukmawati, I., Maris, A. F., & Wulanjani, A. N. (2023). Project Based Learning (PjBL) model with STEM approach on students' conceptual understanding and creativity. *Jurnal Pendidikan IPA Indonesia*, *12*(3), 401–409. https://doi.org/10.15294/jpii.v12i3.42973

Prayitno, M. A., Haryani, S., Wardani, S., & Wijayati, N. (2024). Chemoentrepreneurship-based learning: Influence on social and vocational skills. *Lumat*, *12*(2), 1–17. https://doi.org/10.31129/LUMAT.12.2.2067

Prayitno, M. A., Lutfianasari, U., & Nugroho, D. E. (2020). The effectiveness of greenpreneurship course for students' communication ability and entrepreneurial interest. *Thabiea : Journal of Natural Science Teaching*, *3*(2), 141. https://doi.org/10.21043/thabiea.v3i2.8348

Prayogi, R. D., & Estetika, R. (2020). Kecakapan Abad 21: Kompetensi digital pendidik masa depan. *Manajemen Pendidikan*, *14*(2), 144–151. https://doi.org/10.23917/jmp.v14i2.9486

Purwanti, Sunarno, W., & Ratnasari, N. (2022). Studi Literatur Pembelajaran Project Based Learning Terhadap Keterampilan Berpikir Kreatif IPA SMP. *FORDETAK: Seminar Nasional Pendidikan: Inovasi Pendidikan Di Era Society 5.0* , 148–162.

R. Mursid, Saragih, A. H., & Hartono, R. (2022). The Effect of the Blended Project-based Learning Model and Creative Thinking Ability on Engineering Students' Learning Outcomes. *International Journal of Education in Mathematics, Science, and Technology*, *10*(1), 218–235. https://doi.org/10.1063/5.0114791

Rahayu, S. U., & Tisnawati, N. M. (2014). Analisis Pendapatan Keluarga Wanita Single Parent (Studi Kasus Kelurahan Sesetan , Kecamatan Denpasar Selatan , Kota Denpasar). *Jurnal Ekonomi Kuantitatif Terapan*, *7*(2), 83–89.

Rizkasari, E., Rahman, I. H., & Aji, rima T. (2022). Penerapan Model Pembelajaran Project Based Learning untuk Meningkatkan Hasil Belajar dan Kreativitas Peserta Didik. *Jurnal Pendidikan Tambusai*, *6*(2), 14514–14520. https://doi.org/10.26740/jvte.v1n1.p28-37

Ruwanda, N. D., & Andriana, E. (2023). Penerapan model PjBL dalam meningkatkan kreatifitas belajar peserta didik. *Didaktik : Jurnal Ilmiah PGSD STKIP Subang*, *9*(5), 616–626. https://doi.org/10.36989/didaktik.v9i5.1945

Saefudin, A. A. (2012). Pengembangan kemampuan berpikir kreatif siswa dalam pembelajaran matematika dengan pendekatan Pendidikan Matematika Realistik Indonesia (PMRI). *Al-Bidayah*, *4*(1), 37–48. https://doi.org/10.14421/albidayah.v4i1.10

Sari, R. T., & Angreni, S. (2018). Penerapan model pembelajaran project based learning (PjBL) upaya peningkatan kreativitas mahasiswa. *Jurnal VARIDIKA*, *30*(1), 79–83. https://doi.org/10.23917/varidika.v30i1.6548

Setiawan, L., Wardani, N. S., & Permana, T. I. (2021). Peningkatan kreativitas siswa pada pembelajaran tematik menggunakan pendekatan project-based learning. *Jurnal Pembangunan Pendidikan: Fondasi Dan Aplikasi*, *8*(1), 1879–1887. https://doi.org/10.21831/jppfa.v8i2.40574

Shafi, M., Zoya, Lei, Z., Song, X., & Sarker, M. N. I. (2020). The effects of transformational leadership on employee creativity: Moderating role of intrinsic motivation. *Asia Pacific Management Review*, *25*(3), 166–176. https://doi.org/10.1016/j.apmrv.2019.12.002

Surya, A. P., Relmasira, S. C., & Hardini, A. T. A. (2018). Penerapan model pembelajaran project based learning (PjBL) untuk meningkatkan hasil belajar dan kreatifitas siswa kelas III SD

Negeri Sidorejo Lor 01 Salatiga. *Jurnal Pesona Dasar*, *6*(1), 41–54. https://doi.org/10.24815/pear.v6i1.10703

Yanti, R. A., & Novaliyosi, N. (2023). Systematic literature review: Model pembelajaran project based learning (PjBL) terhadap skill yang dikembangkan dalam tingkatan satuan pendidikan. *Jurnal Cendekia : Jurnal Pendidikan Matematika*, *7*(3), 2191–2207. https://doi.org/10.31004/cendekia.v7i3.2463

Zulyusri, Z., Elfira, I., Lufri, L., & Santosa, T. A. (2023). Literature study: utilization of the PjBL model in science education to improve creativity and critical thinking skills. *Jurnal Penelitian Pendidikan IPA*, *9*(1), 133–143. https://doi.org/10.29303/jppipa.v9i1.2555